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Use of Remote Sensing and GIS Techniques for Land Use and Land Cover Mapping of Tuticorin Coast, Tamilnadu

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Abstract:

The study area (8° 43' - 8° 51' N latitude and 78° 5' - 78° 10' E longitude) falls in the east coastal belt, west of Tuticorin, Tamil Nadu, India. Land use and Land cover is an important parameter for developmental planning. In the present study an attempt has been made to generate the land use and land cover map from Satellite (IRS) 1C, linear image self-scanning (LISS) III of geocoded with UTM projection, sheroid and datum WGS-84, Zone North 44 generated from the total bands 4 on a 1:50,000 scales, was used unsupervised classification and topographical maps, and enhanced for better interpretation. A process of integrating remote sensing techniques and field data to accurately map landuse and land cover of the study area catchment is described. Major problem with the study area can be identifies as are (i) Rapid Growth of Population and (ii) Unplanned growth of the city both horizontally in all direction and vertically also. Field observation shows the current status and issues of coastal environmental problems. Finally, a maximum likelihood classifier was applied to classify the satellite images. Six major landuse classes were identified and mapped for the study area. These are: Cultivated land, Salt pans, Barren land, Shrubs and Water bodies. The study observed that cultivated land is dominant in Tuticorin and its surroundings followed by salt pans. The study recommends the use of satellite imageries for future environmental monitoring studies.

Keywords: Linear image self-scanning, unsupervised classification, land use and land cover, cultivated land, Environmental monitoring

1.0 Introduction:

Coastal regions are the most important and thickly populated zone in the world. Coastal resources have been under intensive pressure, changes are one of the important aspects of global changes (Li Xiubin, 1995). In world population, 47.2% lives in urban settlements and generate nearby coastal area under increased pollution from natural process such as reclamation, dredging and waves, tides and the anthropogenic process like municipal sewage, urban and industrial activities. Public pressure on coastal zones around the world has increased dramatically in the last 50 years (Selvam and Sivasubramanian 2012). Land cover change has been described as the most significant regional anthropogenic disturbance to the environment (Roberts et al, 1998). In essence both land use and cover changes are products of prevailing interacting natural and anthropogenic processes by human activities. Land use and cover change and land degradation are therefore driven by the same set of proximate and underlying factor elements central to environmental processes, change and management through their influence on biodiversity, heat and moisture budgets, trace gas emissions, carbon cycling, livelihoods and a wide range of socio-economic and ecological processes (Desanker et al., 1997; Verbug et al., 2000; Verburg et al., 2002; Fasona and Omojola, 2005). Landuse is a product of interactions between a society's cultural background, state, and its physical needs on the one hand, and the natural potential of land on the other (Hwang, C and Ku, C. Y. 2004).

India has the fastest rate of deforestation in the world. Competing land uses (agriculture and human settlements mainly) are contributing to the decline of forest and woodland areas and the rising demand for fuel wood and charcoal is also a major cause of deforestation (Ademiluyi et al 2008). Over harvesting, agricultural encroachment and

unregulated burning are believed to be contributing to the decline of many species in the wild (Alaguraja et al 2010; John Prince Soundranayagam et al 2011). Depletion and degradation of the natural resource base intensifies competition to less stressed areas. Nonetheless, the point being made is that the environment is so valuable and the inhabitants so precious that the future need not be left to chance or to some curious form of evolution (Karwariya Sateesh and GoyalSandip 2011; Santhiya et al 2010). This paper therefore examines the relevance of some land use and land cover mapping methods in Tuticorin and their contributions to the emerging patterns in global land cover and land use studies. In addition, the study examines the need for proper geomanagement of land and the importance of the availability of detailed, accurate and up-to-date geoinformation in the proper management of land in Tuticorin.

2.0 Material and Methods:

2.1Study Area:

Historically, Tuticorin is famous for its maritime activity and pearl culture. It was the seaport of the Pandyan kingdom; it was later taken over by the Portuguese in 1548, captured by the Dutch in 1658, and ceded to the British in 1825. The lighthouse built in 1842 marked the beginning of the history of harbour development in the city. Tuticorin was established as a Municipality in 1866. It attained the status of Corporation on 5th August, 2008 after 142 years. The city was industrially developed after the port construction and became district headquarters in the year 1986. After the formation of the district headquarters, the economic development was boosted and began to develop rapidly. Therefore, the urban expansion takes place in the different parts of the city during the study period. The study area (8° 43' - 8° 51’ N latitude and 78° 5' - 78° 10' E longitude) falls in the east coastal belt, west of Tuticorin, Tamil Nadu, India (Figure 1). The district of Mannar (Bay of Bengal) lies south and southwest of the district of Tirunelveli, west and northwest of the district of Virudhunagar and north of the district of Ramanathapuram. The study area covers geographical area of 154 sq.km. The watershed is drained by a stream network oriented in the NW–SE direction and is of ephemeral in nature. The topographic elevation varies from 26.22 m amsl to a few meters amsl near Tuticorin town and slopes from west to east. The slope is gentle in the western and the central part and nearly flat in the eastern part of the watershed. The area receives rainfall during the northeast monsoon season, which is active during the months of October–December. The long-term average annual rainfall of Tuticorin town is 568 mm (IMD data). The land is utilized for cultivation of cotton, maize and some medicinal plants. Some of the land is fallow and some barren with vegetation such as thorny shrubs with a thin cover of dry grass and palms.

2.2Geology and Hydrology:

About 90 % of the study area is made up of sedimentary rocks of Tertiary to Recent age comprising of Shell limestone and Sand, Tuffaceous Kankar, Sand (Aeolian deposits) etc., and the remaining area is covered by mixed and composite Genesis of Proterozoic age of crystalline rocks (Figure 2). The general Tuticorin district stratigraphic succession is presented below (Table 1). The Archaean groups of formations are crystalline and metamorphic, and finely foliated with a general NW–SE trend described by Balasubramanaian et al. (1993). The area is covered with black soils in the western part (Sankarapari area), red soil (sandy loam to sandy soil) in the central part and alluvial Sandy soils (Coastal area) in the eastern part.

The maximum soil thickness is about 3 m. The sandy soils originated from sandstones and these have low soil moisture retentivity. The alluvium soils are wind-blown sands and shells constitute beach sand and coastal dunes, which have very low soil moisture retentivity. The important aquifer systems in the district are constituted by i) unconsolidated & semi consolidated formations and ii) weathered and fractured crystalline rocks. The porous formations in the district include sandstones and clays of Recent to subrecent (Quaternary) and Tertiary age. The Recent formations comprising mainly sands, clays and gravels are confined to major drainage courses in the district. The maximum thickness of alluvium is 45.0 m bgl, whereas the average thickness is about 25.0 m. Ground water occurs under water table and confined conditions in these formations and is being developed by means of dug wells and filter points. The productive zones are encountered in the depth range of 29.5 to 62 m bgl. Alluvium, which forms a good aquifer system along the Vaippar and Gundar river bed which is one of the major sources of water supply to the villages.

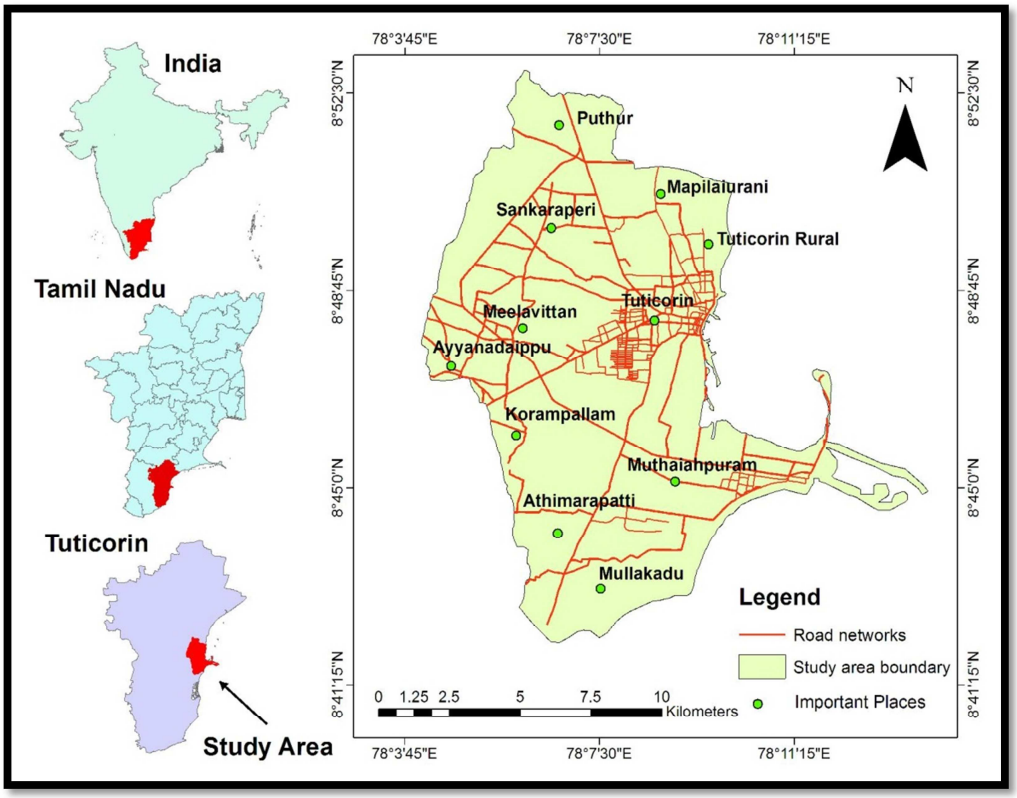

Figure 1: Location map of the study area

Table 1: Geology of the study area

PERIOD	AGE	FORMATION	LITHOLOGY
Quaternary	Holocene to Recent	Alluvium Colluvium	Red soil, Coastal sandClay, River Alluvium, Laterite, Red Teri Kankar, TuffaceousKankar, Shell limestone,Calcareous Sandstone
Tertiary	Mio-Pliocene	Panamparai Sandstone	Hard, compact, Calcareous sandstone, Shell Limestone
Proterozoic	Precambrian	Crystalline complex	Charnockite, Mixed and c,omposite Genesis Peliticgneiss Calc-granulite, Quartzite

2.3 Methods:

Preparation of various thematic data such land use and Land cover using LISS-III Pan Data and create a land use land cover map from satellite imagery using supervised classification. The Tuticorin topomaps (1969) were digitized and the extent of the Settlement, saltpan, wasteland, Agricultural land and Water bodies were extracted using ArcGIS 9.2software. The Indian Remote sensing Satellite (IRS) 1C, linear image self-scanning (LISS) III of geocoded with UTM projection, datum WGS-84, Zone North 44 generated from the total bands 4 on a 1:50,000 scales, was used for the present study. The Survey of India toposheet maps 58H/13, 58H/14, 58L/1&5, 58L/2 on a scale of 1:50,000 equal to the corresponding imagery were used for the preparation of thematic maps.

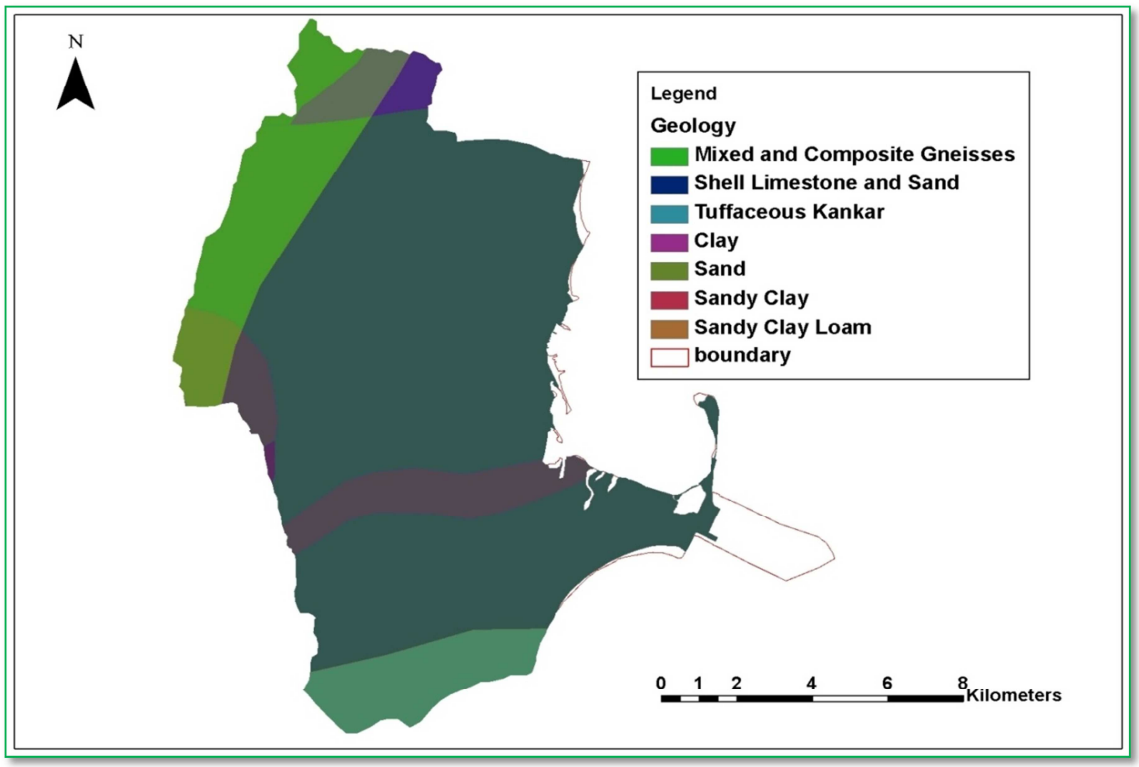

Figure 2: Geology map of the study area

2.4 Field Surveys:

Field surveys will be conducted within the study areas to determine the major types of land use and land cover. Such data would be used in two aspects of the mapping of land use land cover. Firstly it will aid in land use and land cover classification, by associating the ground features of a specific type of land use and land cover with the relevant imaging and spectral characteristics. Secondly, ground data will be used for accuracy assessment of the developed land use and land cover maps.

3.0 Results and Discussion:

3.1 Landuse/Landcover:

The landuse map for the study area was prepared with the help of image interpretation keys such as tone, texture, drainage, structure fabric and relief using both toposheets as well as geocoded data. Further demarcated areas were confirmed though ground truth data (Selvam et al 2011). The various landuse found in the study area and their map overlay technique is consent of GIS. In the Tuticorin Corporation 40% of the area is covered by cultivated land. Salt pans with water and salt pans occupy 29% of the area followed by barren and shrubs land 15% and Industry cover is 13%. Marginal area is occupied by tanks, water, channel and others (Figure 3).

3.2 Land with or without shrubs:

In the imagery these lands were identified with pale yellowish tint as well as coarse to smooth texture. In the study area these type of land is available nearby western portion of the study area.

3.3 Water bodies:

In the study area number of tanks was present which were setting water from the korampalam channel in the area which was flowing from north-south direction. In the imagery tanks were identified with blue tint (shallow water) and black tint (deep water).

3.4 Agriculture land:

Land that is barren today may remain barren forever. If it has a problem that has made it too difficult to farm, it may be entirely too costly to make it farmable. You might have to bring in soil to

cover rock or gravel. There may be not enough rain to support any crop. The land may be permafrost or steep surfaces that should not be tilled. There may be toxins in the soil and in water that drains over the soil. It may have several of these problems. Cultivate lands of the study area are primary used for farming activities. It includes food crops, horticultural crops and commercial crops of different kinds under and rained conditions, which are however grown under different session, different farming activities and land use tenure system.

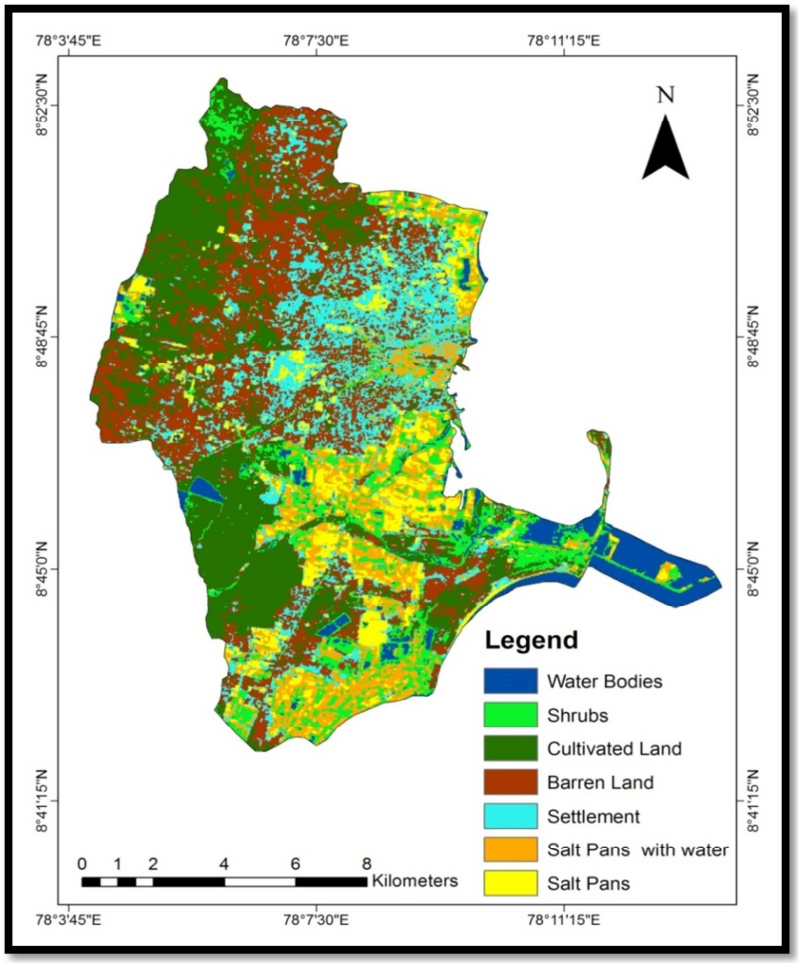

Figure 3: Landuse/Land Cover map of the study area

3.5 Saltpan:

Tuticorin Corporation thousands of acres of land is utilities for production of salt. Originally salt was found in sea water but later it was found that the underground water contains more salt (Selvam et.al 2010). Now they have bored holes into the earth through which the underground water is pumped to the surface. The ground is leveled with a slight slope towards one direction. The land is divided into squares of 20-25 feet called `pans' and from one pan the water drains into the other pan. The underground water comes into the first pan in the field where by evaporation it becomes more concentrated and its specific gravity gradually increases. It is let out into the second and sub-sequently into the third and fourth pans in the field. In the last pan where its specific gravity is high, sodium chloride separates into crystals. In the first pan magnesium crystals precipitate and appear like white, needlelike crystals. This is collected and sent for use for other industries. As the production of salt remains disrupted owing to incessant rainfall, there is a mismatch between supply and demand for salt. In the imagery tanks were identified with light to dark yellowish tint.

3.5 Irrigation tanks:

Tamiraparani River has a number of canal systems in Murappanad and srivaikundam. In recent years famers draw out the groundwater along the river banks and around the irrigation tank though large diameter dugwell and dug-cum bore well. Korampallem tank are important irrigation tanks in the study area (Figure 4).

3.6 Sandy beach:

Sandy beaches are the product of waves interacting with a sandy beach at the shoreline. The sandy beaches are extensively developed along the entire coast of study area except at some places. Tuticorin is covered by long and extensive sandy beach. It trends in north-south direction. Well developed sandy beach is identified below south harbour breakwater. This beach is dominated by an admixture of quartz, feldspars and mica minerals.

3.7 Spits:

A spit is a small point of low tongue or narrow bankment, commonly consisting of sand or gravel deposited by a long-shore drifting and having one end attached to the mainland and other terminating in the open sea. Two spit formations have been observed in south of the urban coast. Normally the formation of spit has been attributed to the movement and deposition of materials by long shore current. The spit near Tuticorin is 0.75 to 2 km long and tongue shaped. Tuticorin spit has resulted by long shore currents during monsoon and the sediments discharged by Tamiraparani River.

3.8 Beach ridges:

Beach ridges are moderately undulating terrain features of marine depositional type, formed during Pleistocene to recent age, in the plains of the study area. They are low, essentially continuous beach or beach dune materials (sand, gravel and shingle) heaped up by the action of wave and currents on the backshore of a beach beyond the present limit of storm waves or the reach of ordinary tides, and occurring as a single or as one of a series of approximately parallel deposits.

3.9 Mudflat:

Mudflat is a flat area containing a fluid to plastic mixture of finely derived particles of solid material mainly silt and clay water. They are always associated with silted environments like lagoons, estuaries and other embankments. Mudflats are formed by the deposition of fine inorganic material and organic debris in particulate form. Mud flats are wide expense of deposit of clay, silt, ooze, etc. Mudflats are well developed at the river mouth of Koramballam Oodai, an estuarine environment. They appear as dark black tone in satellite imagery is highly reworked.

3.10 Dune complex:

Dune complex is an important geomorphic unit comprising of active and loose sediment heaps with negligible amount of vegetation. In this zone, the aeolian activity is reportedly high resulting in migration without a major change in their shapes. It indicates the age of late Pleistocene to Recent. Tuticorin is situated in dune complex.

3.11 Teri dune complex:

Teri dune complex is an undulating terrain having loose heaps of red color sand and silt dust of aeolian origin. They represent Pleistocene to Recent age of formation. They appeared as round to oval shaped mounts with dense vegetation. It is assumed that the fierce and continuous winds of south west monsoon by sweeping up vast clouds of dust from the dry surface of the red loam, exposed at the base of the hills must have brought and deposited their load of sediments near the coast over the plain to form Teri dune complex. All dune complexes in this area are trending in the northeast to southeast direction. In recent years, these Teri dune complexes are being utilized for cultivation also. It is identified in greenish yellow color in satellite imagery.

4.0 Environmental problems due to the changes in Tuticorin coastal region:

Tuticorin has a Rapid Growth of Population and Unplanned growth of the city both horizontally in all direction and vertically also. Due to enhanced importance of the city and its environment, the migration of people is attracted towards the city, and occupies land for businesses, commercial and residential purposes. Many of the developments have come up in the recent years, which have affected the study area in a drastic way. So there is a need for proper planning for the careful handling of this alarming situation. The dumping of the residential solid waste and untreated domestic wastewater are mixing to the sea water and its affects the coastal ecology (Figure 5).

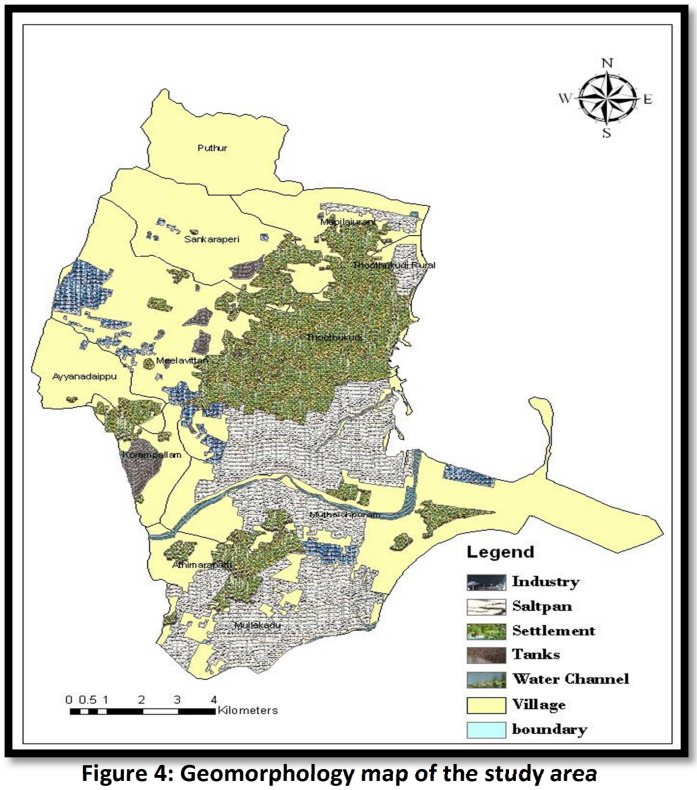

Figure 4: Geomorphology map of the study area

Table 2: Data showing percentage of land cover within the study area

Land Use Land Cover	Total Percentage
Cultivated land	40%
Salt pans with water	20%
Salt pans	09%
Barren land	09%
Shrubs	06%
Industry	13%
Water bodies	03%

5.1 Industrial activities nearby coastal region:

Tuticorin coastal area comprises of the industries like SPIC, TAC, thermal power stations, Sterlite, fertilizers plant, industries another associated small scale industries (Figure 6). SPIC, TAC industrial zone and other several zones are located near to the sea shore. These industrial units may discharge the partial treated and untreated effluents that containing heavy metals and other toxic chemicals that severely affecting the coastal and marine ecology (Figure 7). Especially, in South Tuticorin coast due to these industries Korampallam channel is severely affected and it is the very sensitive ecological area for birds migrating of this place.

Figure 5: Industrial waste dumpsite within the study area (Sterlite)

Figure 6: Industrial activity of Tuticorin coastal environment

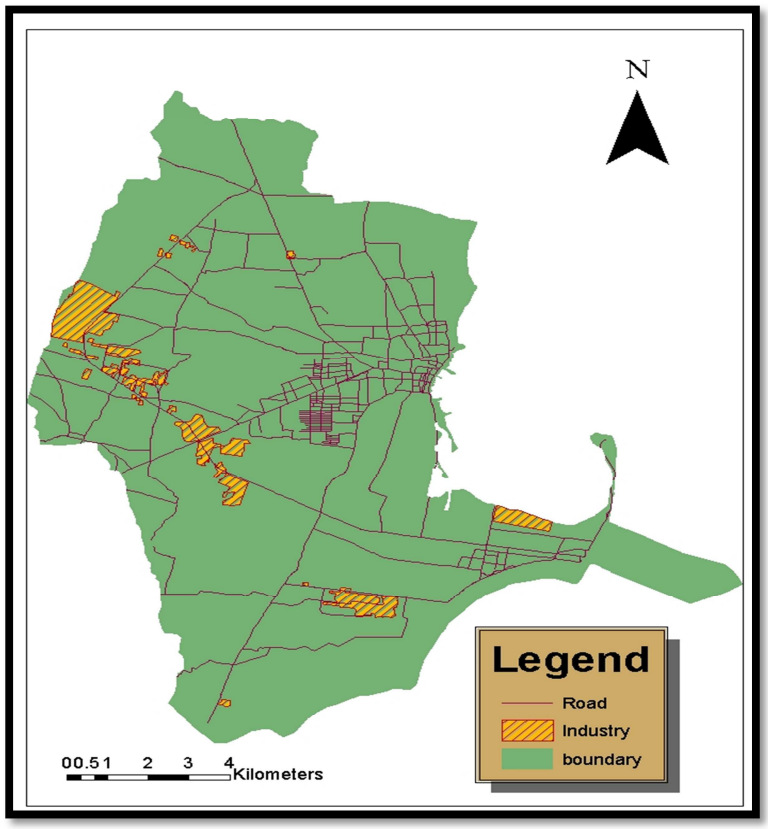

Figure 7: Showing the Industrial map of study area

6.0 Conclusions:

GIS and Remote Sensing techniques is a powerful technique for mapping and evaluating the Land Use and Land Cover study in coastal environment. This basic study shows how to classify land use and land cover from satellite imagery, I calculated land use and land cover area for the study area using supervised classification. The Tuticorin coastal zone problem mainly due to population expansion, salt pans and industrial activity. The land use and land cover map clearly shows that area of cultivate land is higher than others. The map shows clearly in the coastal landforms increase in industries, built-up land, and in other agriculture land, forest area is decreased. Mostly the contributors for the

development are identified as waste land. Field observation also proves that polluted in the Tuticorin coastal zone because of fishing, industrial and waste dumpsite activities. Accurate coastal zone regulation should be strictly implemented to protect the construction and other related activities near to the Tuticorin coast.

7.0 Acknowledgement:

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References:

1) Ademiluyi, I. A. Okude, A. S. and Akanni, C. O. (2008): An appraisal of landuse and landcover mapping in Nigeria. African Journal of Agricultural Research., 3:581-586.
2) Alaguraja, P. Durairaju, S. Yuvaraj, D. Sekar, M. Muthuveerran, P. Manivel, M. Thirunavukkarasu, A. (2010): Land Use and Land Cover Mapping – Madurai District, Tamilnadu, India Using Remote Sensing and GIS Techniques. International journal of Civil and Structural Engineering., 1 (1):91-100
3) Balasubramanaian, A. R. Thirugnana, S. Chellaswamy, R. and Radhakrishnan, V. (1993): Numerical modeling for prediction and control of saltwater enchroment in the coastal aquifers of Tuticorin, Tamil Nadu Tech. Report., 21-23
4) Desanker, P. V. Frost, P. G. H. Justice, C. O. Scholes, R. J. (1997): The Miombo Network: Frameworks for a terrestrial transect study of Land Use and land Cover Change in the Miombo ecosystems of Central Africa. IGBP Report., 41.
5) Fasona, M. J. Omojola, A. S. (2005): Climate Change, Human security and Communal Clashes in Nigeria. Paper presented at an International Workshop on Human Security and Climate Change, Asker, Norway.
6) Hwang, C. Ku, C. Y. (2004): Exploring the Optimum Spatial Resolution forSatellite Imagery: A Coastal Area Case Study. In Bartlett, D & Smith,J (eds), GIS for Coastal Zone Management CRC Press LLC, USA., 77-93
7) John Prince Soundranayagam, Chandrasekar, N. Sivasubramanian, P. and Divya, C. (2011): An Analysis of Land use and Land cover change of Tuticorin, Tamilnadu using Internet GIS. Paper presented at an International Conference on Geospatial World Forum, Heyderabad
8) Li Xiubin. (1995): A review of the international researches on land use/cover change", ActaGeographica Sinica., 51 (6):553.
9) Karwariya Sateesh, GoyalSandip. (2011): Land use and Land Cover mapping using digital classification technique in Tikamgarh district, Madhya Pradesh, India using Remote Sensing. International Journal of Geomatics and Geosciences., 2(2):519-529
10) Roberts, D. A. Bastita, G. T. Pereria, S. L. G. Waller, E. K. Nelson, B. W. (1998): Change Identification Using Multitemporal Spectral Mixture Analysis. Applications in eastern Amazonia in Lunetta RS, Elvidge CD (eds)Remote Sensing and 21 Change Detection Environmental MonitoringMethods and applications. Sleeping Bear Press Inc, Michigan
11) Santhiya, G. Lakshumanan, C. Muthukumar, S., (2010): Mapping of Landuse/Landcover Changes of Chennai Coast and Issues related to Coastal Environment Using Remote Sensing and GIS. International Journal of Geomatics and Geosciences., 1 (3):563- 576
12) Selvam, S. Seshunarayana, T. Manimaran, G. Sivasubramanian, P. Manimaran, D. (2010): Groundwater Investigation using Geoelectrical Survey: A case study from Kanukunta Village, Andhra Pradesh, India. journal of Outreach., IV:59-62
13) Selvam, S. ChindamNarsimhulu. Manimaran, G. Sivasubramanian. P. (2011): Geomorphological and textural characteristics of sediments of St. Marys Island Western continental shelf, India. Archives of Applied Science Research., 3 (6):480-487
14) Selvam, S. Sivasubramanian, P. (2012): Groundwater potential zone identification using geoelectrical survey: A case study from Medak district, Andhra Pradesh, India. International Journal of Geomatics and Geosciences., 3 (1):55-62
15) Verburg, P, H. Chen, Y. Soepboer, W. Veeldkamp, T. A. (2000): GIS-based modeling of human-environment interactions for natural resourcemanagement applications in Asia". Proceeding 4th InternationalConference on integrating GIS and Environmental Modelling: Problems, Prospect and Research Needs, Banff, Alberta, Canada.
16) Verburg, P. H. Veldkamp, W. S. A. Espaldon, R. L. V. Mastura, S. S. A. (2002): Modeling the spatial dynamics of regional landuse: the CLUE-SModel. Environ. Manage., 30(3):301-405.